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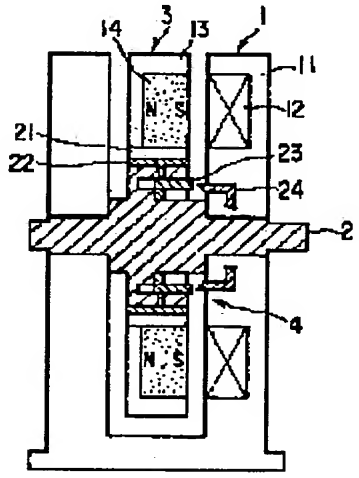
(54) PERMANENT MAGNET TYPE DYNAMO-ELECTRIC MACHINE

(57)Abstract:
PROBLEM TO BE SOLVED: To enable a wide range of operation from low-speed operation to high-speed operation by providing this machine with a field weakening mechanism which has a mobile magnetic substance to short-circuit the magnetic circuit of a permanent magnet when a rotor comes to high-speed revolution above a given value.
SOLUTION: When the revolution of a rotor 3 goes high, and comes to high- speed revolution above a given number of revolutions, a mobile magnetic substance 22 gets in mobile condition, and it sticks fast to a permanent magnet 14 by the centrifugal force made by rotor revolution and the magnetic force of the permanent magnet 14, and the mobile magnetic substance 22 short-circuits to both ends of the permanent magnet 14 and constitutes a leakage magnetic circuit. By such field weakening mechanism 14, the quantity of crosslinked magnetic fluxes of an armature coil 12 by the permanent magnet 14 can be adjusted, so a wide range of operation from low-speed revolution to high-speed revolution can be materialized by adjusting and suppressing the voltage.



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CLAIMS

[Claim(s)]
[Claim 1] The permanent magnet type dynamo-electric machine characterized by having the field weak device in which it has the stator equipped with the armature coil, Rota where opposite arrangement of the permanent magnet of the main field was carried out through the predetermined opening to this stator, and the movable magnetic substance which short-circuits the magnetic circuit of said permanent magnet when predetermined conditions are satisfied.
[Claim 2] Predetermined conditions are a permanent magnet type dynamo-electric machine according to claim 1 which is any [of the abnormalities of the high-speed rotation beyond the predetermined value of said Rota, and the preceding paragraph side circuit of said Rota, and the loaded condition beyond a predetermined value] one.
[Claim 3] Said movable magnetic substance which a field weak device is formed in a T character configuration, and the front end section side is arranged possible movable with a predetermined opening to a permanent magnet, and has a tongue-shaped piece in the direction of 1 flank of the back end section, The stopper with which the long hole which inserts in this movable magnetic substance is formed, and the tongue-shaped piece of the movable magnetic substance concerned is usually engaged at the time of operation, and when it is said predetermined conditions, The permanent magnet type dynamo-electric machine according to claim 1 with which said stopper is moved, it has the stopper push member which secedes from a tongue-shaped piece from said long hole, and this movable magnetic substance from which it seceded is characterized by making it stick to the permanent magnet concerned using the centrifugal force of the Rota rotation, and the magnetism of a permanent magnet.
[Claim 4] A field weak device is a permanent magnet type dynamo-electric machine according to claim 1 characterized by having the elastic body which connects the tabular movable magnetic substance arranged possible movable with a predetermined opening to said permanent magnet, and this movable magnetic substance and revolving shaft, resists elastic force, the centrifugal force of the Rota rotation, and the magnetism of a permanent magnet, and is made to stick the movable magnetic substance to said permanent magnet.
[Claim 5] Said movable magnetic substance which a field weak device is formed in a T character configuration, and the front end section side is arranged possible movable with a predetermined opening to a permanent magnet, and has a protruding piece with the taper section in the direction of 1 flank of the back end section, At the taper section of this movable magnetic substance, the slip ring which has the taper section in the side which counters, and the time of said predetermined conditions The permanent magnet type dynamo-electric machine according to claim 1 which is made to carry out predetermined distance retreat of said slip ring, and is characterized by having the drive control section stuck to the permanent magnet concerned using the centrifugal force of the Rota rotation of said movable magnetic substance, and the magnetism of a permanent magnet.
[Claim 6] For the movable magnetic substance arranged possible movable with a predetermined opening to a permanent magnet, and said permanent magnet of this movable magnetic substance, a field weak device is a permanent magnet type dynamo-electric machine according to claim 1 characterized by having the electromagnet which is installed in the opposite side and made to adsorb and secede from said movable magnetic substance.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the permanent magnet type dynamo-electric machine which used the permanent magnet.
[0002]
[Description of the Prior Art] Generally, the dynamo-electric machine of a shaft-orientations permanent magnet field method has the following composition. Opposite arrangement of this dynamo-electric machine is carried out with an opening predetermined in a stator and Rota, among those it has an armature core and this armature core is looped around the coil by the stator side. The permanent magnet which generates field magnetic flux is fixed and arranged by the Rota side.
[0003] This permanent magnet type dynamo-electric machine is excellent in small and high power at maintenance nature, and since adjustable [of an exciting current] is possible compared with an induction machine, it is excellent in the controllability, and it is widely used by many technical fields containing an electric propulsion system etc. by recently.
[0004] Originally, although the motor used for electric propulsion systems, compressors, etc., such as an electric vehicle, is constant torque operation in a low-speed field, it serves as constant output operation in a high-speed field. Therefore, although terminal voltage becomes large in proportion [almost] to a rotational frequency in a constant torque field, since there may also be few currents, it is desirable [torque is small, and] in a constant output area for an electrical potential difference to serve as a fixed value.
[0005] However, since the permanent magnet type dynamo-electric machine uses the permanent magnet for the field, it becomes fixed [field magnetic flux]. Consequently, although the amount of magnetic flux interlinked with an armature coil is fixed, if the rotational frequency of Rota is raised, since induced voltage will become high in proportion to this rotational frequency, if it becomes higher than the electrical potential difference of the inverter by the side of the dynamo-electric machine preceding paragraph, a current will stop flowing into a dynamo-electric machine from an inverter side, and rotation of a dynamo-electric machine will serve as impossible. Although what is necessary is just to enlarge the electrical potential difference of an inverter simply in enabling high-speed rotation of this dynamo-electric machine, the apparent power of an inverter becomes large, and an inverter is enlarged, and conversion efficiency also worsens.
[0006] Then, the technique of equivalent field-weaking control in which it was made to reduce the field magnetic flux interlinked with an armature coil is used by passing conventionally the armature current of d shaft component (vector component) of armature reaction which acts on field magnetic flux and hard flow.
[0007]
[Problem(s) to be Solved by the Invention] However, since the relative permeability of a permanent magnet serves as a value (1.1) near vacuous relative permeability (1.0), magnetic opening length serves as the sum of permanent magnet thickness and mechanical opening length, and the above field-weaking-control techniques become very large, when the field of an armature side to Rota is seen. Consequently, in order to acquire the effectiveness of a field weakening appropriately, the armature current of d shaft must enlarge considerably, and poses a problem efficiently and in temperature, and

there is a problem also from a practical field.
[0008] Moreover, the problem that an anti-field is directly added according to armature reaction is in the permanent magnet itself, and when there is a possibility that a property may deteriorate further (demagnetization), failure of the inverter of magnetic-flux weak inside also poses a problem. The high electrical potential difference by back EMF generated by Rota around which it continues turning by inertia flows into an inverter or direct-current side as it is, and this may have a bad influence on it in various circuits, when an inverter stops operating to the midst which is performing eye magnetic-flux weakness for a certain reason.
[0009] Then, since the problem of abnormalities, such as an inverter, can be considered with the conventional field-weaking-control technique, it is used where the width of face of a high-speed rotation region is narrowed, and operation of the larger rotational-speed range is difficult.
[0010] This invention was made in view of the above-mentioned actual condition, enables operation wide rang from low-speed rotation to high-speed rotation, controls induced voltage certainly especially at the time of high-speed rotation and the abnormalities of a preceding paragraph circuit etc., and is to offer a permanent magnet type dynamo-electric machine with the high safety which does not have a bad influence on a preceding paragraph circuit at all.
[0011]
[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, when the stator equipped with the armature coil, Rota where opposite arrangement of the permanent magnet of the main field was carried out through the predetermined opening to this stator, and Rota become the high-speed rotation beyond a predetermined value, When the preceding paragraph side circuit of said Rota becomes abnormalities and it will be in the loaded condition beyond a predetermined value, it is the permanent magnet type dynamo-electric machine which established the field weak device in which it had the movable magnetic substance which short-circuits the magnetic circuit of a permanent magnet.
[0012] In addition, as a field weak device, the thing of two or more configurations which carry out the following can be considered.
(1) Said movable magnetic substance which one of them is formed in a T character configuration, and the front end section side is arranged possible movable with a predetermined opening to a permanent magnet, and has a tongue-shaped piece in the direction of 1 flank of the back end section, The stopper with which the long hole which inserts in this movable magnetic substance is formed, and the tongue-shaped piece of the movable magnetic substance concerned is usually engaged at the time of operation, and when it is said predetermined conditions, Said stopper is moved, it has the stopper push member which secedes from a tongue-shaped piece from said long hole, and this movable magnetic substance from which it seceded is the configuration stuck to the permanent magnet concerned using the centrifugal force of the Rota rotation, and the magnetism of a permanent magnet.
(2) Other one is the configuration of having prepared the elastic body which connects the tabular movable magnetic substance arranged possible movable with a predetermined opening to a permanent magn t, and this movable magnetic substance and revolving shaft, resists elastic force, the centrifugal force of the Rota rotation, and the magnetism of a permanent magnet, and is made sticking the movable magnetic substance to said permanent magnet.
(3) Said movable magnetic substance which one of further others is formed in a T character configuration, and the front end section side is arranged possible movable with a predetermined opening to a permanent magnet, and has a protruding piece with the taper section in the direction of 1 flank of the back end section, At the taper section of this movable magnetic substance, the slip ring which has the taper section in the side which counters, and the time of said predetermined conditions Predetermined distance retreat of said slip ring is carried out, and said movable magnetic substance is the configuration of having prepared the drive control section stuck to the permanent magnet concern d using the centrifugal force of the Rota rotation, and the magnetism of a permanent magnet.
(4) Th movabl magnetic substanc with which one of further others has been arranged possible movable with a predetermined opening to a permanent magn t, and said p rmanent magnet of this movable magnetic substance are install d in the opposite side, and are the configuration of having formed the electromagnet mad adsorb d and seceding from said movable magn tic substance.
[0013] This invention by having provided the above means a field weak device Since the movable

magnetic substance is moved using the centrifugal force of the Rota rotation, the magnetism of a permanent magnet, etc. and it is made to stick to a permanent magnet when it will be in the loaded condition beyond the high-speed rotation beyond the predetermined value of Rota, the abnormalities of the Rota preceding paragraph side circuit, and a predetermined value Since the magnetic circuit of a permanent magnet connects too hastily and a part of magnetic flux of this permanent magnet turns into leakage flux through the movable magnetic substance, the amount of flux linkages with an armature coil can decrease, and the electrical potential difference generated from a dynamo-electric machine can be stopped.

[0014]

[Embodiment of the Invention]

(Gestalt of the 1st operation) Drawing 1 and drawing 2 are the direction sectional views of a revolving shaft and field weak organization charts showing 1 operation gestalt of the permanent magnet type dynamo-electric machine concerning this invention. In addition, the gestalt of this operation is a shaft-orientations gap, and is the example of application of the dynamo-electric machine of 4 pole structures.

[0015] First, it precedes explaining the permanent magnet type dynamo-electric machine concerning this invention, and relation with the conventional dynamo-electric machine is explained. Although there is the equivalence field-weaking-control method for reducing the magnetic flux of the permanent magnet by the armature reaction of negative d shaft current, and adjusting terminal voltage to a permanent magnet type dynamo-electric machine conventionally, the armature current remarkable for reducing the amount of magnetic flux of a permanent magnet is needed. For this reason, the effectiveness of the field weakening by armature reaction is small, and it is difficult to expand a high-speed rotation field. Moreover, an anti-field joins a permanent magnet directly according to armature reaction, and there is a possibility of demagnetizing.

[0016] Then, being based on the above viewpoint, it realizes and the permanent magnet type dynamo-electric machine concerning this invention is explained concretely hereafter. That is, this dynamo-electric machine is constituted by the stator 1 formed in the cross-section concave configuration, Rota 3 supported to revolve pivotable through the revolving shaft 2 by the opening part which makes the concave configuration of this stator 1, and the field weak device 4.

[0017] Said stator 1 is constituted by the armature core 11 which comes to carry out the laminating of the silicon steel plate, and this armature core 11 is looped around the armature coil 12. On the other hand, Rota 3 consists of Rota iron cores 13, and four permanent magnets 14 which have the relation of a unlike pole on the front face of this Rota iron core 13 are fixed and arranged. This permanent magnet 14 is arranged so that N pole may be located in the south pole and its opposite side side it confronts each other a stator 1 side for example, and the field magnetic flux generated from a permanent magnet 14 takes a round of it through the armature core 11 and revolving shaft 2 of a stator 1.

[0018] While said field weak device 4 forms the predetermined clearance 21 between the Rota fixed base of a revolving shaft 2, and a permanent magnet 14, the movable magnetic substance 22 of a T character configuration is inserted in the stopper 23 possible [an attitude] in the direction of a revolving-shaft alignment from this clearance 231.

[0019] That front end section is located in clearance 21 part, and, as for this movable magnetic substance 22, tongue-shaped piece 22a is formed in the direction of 1 flank of the back end section. As a stopper 23 is inserted in the direction which intersects perpendicularly with the path of insertion of the movable magnetic substance 22 from one side face used as the direction of a revolving shaft of the Rota fixed base free [an attitude] and it is shown in drawing 2 , elliptical long hole 23a is formed. And tongue-shaped piece 22a of the movable magnetic substance 22 is always engaging with long hole 23a of a stopper 23, and when it is pushed by the stopper push member 24 and a stopper 23 moves only predetermined distance, it has composition from which it separates from long hole 23a.

[0020] Therefore, according to the gestalt of implementation of the above configurations, the stopper push member 24 is usually set as the location including low-speed rotation and the high-speed rotation below a predetermined value which separated only predetermined spacing from the stopper 23 at the time of rotation. Furthermore, the movable magnetic substance 22 is inserted in long hole 23a of a stopper 23, and tongue-shaped piece 22a of the movable magnetic substance 22 concerned engages with the end side of long hole 23a, and is arranged with the permanent magnet 14 and the predetermined opening.

[0021] If Rota 3 rotates in this condition, in proportion to that rotational frequency, induced voltage becomes large. And when the rotational frequency of Rota 3 becomes high and becomes the high-speed rotation more than a predetermined rotational frequency, the stopp r push member 24 moves forward so that only predetermined distance may push in a stopper 23. Here, since the location of long hole 23a is also moved with migration of a stopper 23, tongue-shaped piece 22a of ******** 22 separates from long hole 23a of a stopper 23.
[0022] Consequently, since the movable magnetic substance 22 will be in flight readiness, it sticks to a permanent magnet 14 by the centrifugal force of the Rota rotation, and the magnetism of a permanent magnet 14. That is, the movable magnetic substance 22 is connected with the two poles of a permanent magnet 14 too hastily, and serves as a leakage magnetic circuit. Since a part of magnetic flux of a permanent magnet 14 turns into leakage flux through the movable magnetic substance 22, the amount of flux linkages with an armature coil 12 decreases by this and rotational speed is controlled, induced voltage is controlled.
[0023] In addition, although the gestalt of the above-mentioned implementation was considered as the configuration which drives the stopper push member 24 when the rotational frequency of Rota 3 became more than a predetermined rotational frequency, the configuration of making the stopper push member 24 driving in an emergency of not detecting the high-speed rotation more than a predetermined rotational frequency, for example, but an inverter etc. stopping operating by a certain cause etc. is sufficient as it. Also in this case, when the movable magnetic substance 22 short-circuits the two poles of a permanent magnet 14, a part of magnetic flux of a permanent magnet 14 turns into leakage flux, and the amount of flux linkages with an armature coil 12 decreases. It can stop the high electrical potential difference by back EMF, and seems consequently, not to have a bad influence on an inverter or direct-current side, even if it continues turning around Rota 3 by inertia.
(Gestalt of the 2nd operation) Drawing 3 and drawing 4 are the Rota block diagrams and the direction sectional views of a revolving shaft showing other operation gestalten of the permanent magnet type dynamo-electric machine concerning this invention.
[0024] The predetermined clearance 31 is formed between the Rota fixed base of a revolving shaft 2, and a permanent magnet 14 as a field weak device 4, and the gestalt of this operation is having the tabular movable magnetic substance 32 arranged into this clearance 31 part. Furthermore, the elastic members 33, such as a spring, are connected with the movable magnetic substance 32 in the revolving shaft 2.
[0025] According to the gestalt of implementation of such a configuration, the high-speed predetermined rotation from low-speed rotation is set up so that the elastic force of an elastic member 33 may excel rather than centrifugal-force + magnetism. Therefore, in a certain loaded condition or a constant torque field, since the movable magnetic substance 32 is separated from the permanent magnet 14, a permanent magnet 14 demonstrates the original engine performance, and the amount of flux linkages with an armature coil 12 becomes large.
[0026] On the other hand, at the time of high-speed rotation, it sets up so that the centrifugal-force + magnetism of the Rota rotation may become larger than spring elastic force. Consequently, in a high-speed rotation field, since the magnetic path which short-circuits the magnetic circuit of a permanent magnet 14 when spring elastic force is resisted and a permanent magnet 14 sticks the movable magnetic substance 32 is formed and a part of field magnetic flux is bypassed, a part of magnetic flux of a permanent magnet 14 turns into leakage flux, and the amount of flux linkages with an armature coil 12 decreases. By this, the terminal voltage of a dynamo-electric machine can be reduced, the inconvenient problem that a current does not flow into a dynamo-electric machine from an inverter is lost, and operation becomes possible over a wide range rotation field.
(Gestalt of the 3rd operation) Drawing 5 and drawing 6 are the direction sectional views of a revolving shaft and field weak organization charts showing 1 operation gestalt of the permanent magnet type dynamo-electric machine concerning this invention.
[0027] The clearance 41 between predetermined [to betwe n the Rota fixed base of a revolving shaft 2 and permanent magn ts 14] in th field weak device 4 in this dynamo-electric machine is formed, and is inserted in the direction of a r volving-shaft alignment possible [an attitude of the movable magnetic substance 42 of a T character configuration] from this clearance 41.
[0028] Protruding piece 42a which that front end section has been arranged at clearance 41 part, bent

this movable magnetic substance 42 in the direction of 1 flank of the back end section, and made the inside part the shape of a taper is formed. And the slip ring 43 which has the taper section in the attitude direction of the movable magnetic substance 42 and the direction which intersects perpendicularly is formed possible [an attitude]. And the taper section of this slip ring 43 and the taper section of protruding piece 42a are set as the condition that each other is engaged.

[0029] If according to the gestalt of implementation of such a configuration it moves in connection with abnormalities in a field, such as an engine speed, a load, temperature, and an inverter, so that the slip ring 43 may retreat, movable can be carried out the taper section of protruding piece 42a engaging with the bottom of the balance of centrifugal-force + magnetism at the taper section of the slip ring 43, so that a permanent magnet 14 may be approached, and it can be made to stick to a permanent magnet 14. By this, the movable magnetic substance 42 can short-circuit the two poles of a permanent magnet 14 like the gestalt of the 1st and the 2nd operation, a part of magnetic flux of a permanent magnet 14 can turn into leakage flux, and the amount of flux linkages with an armature coil 12 can be decreased.

[0030] In the case of the gestalt of this operation, if the slip ring 43 is driven under free conditioning, the optimal operation of a dynamo-electric machine is securable.

(Gestalt of the 4th operation) Drawing 7 is the direction sectional view of a revolving shaft showing 1 operation gestalt of the permanent magnet type dynamo-electric machine concerning this invention.

[0031] The predetermined clearance 51 is formed between the Rota fixed base of a revolving shaft 2, and a permanent magnet 14, and, as for the field weak device 4 in this dynamo-electric machine, the tabular movable magnetic substance 52 is arranged at this clearance 51 part. Furthermore, it is the configuration of arranging an electromagnet 53 to the opposite side, sticking the movable magnetic substance 52 to a permanent magnet 14, or making it deserting by excitation and non-exciting control of this electromagnet 53, in the permanent magnet 14 of the tabular movable magnetic substance 52.

[0032] According to the operation gestalt of such a configuration, an electromagnet 53 under conditions, such as abnormalities of an engine speed, a load, temperature, and an inverter, like the gestalt of the 3rd operation un-exciting or by doing excitation control of If it is made to desert an electromagnet 53 to the movable magnetic substance 52, it is possible to be able to stick the movable magnetic substance 52 to a permanent magnet 14, and to demonstrate the same actuation thru/or same function as a gestalt of the 1st thru/or the 3rd operation by centrifugal-force + magnetism. In addition, although the gestalt of each above-mentioned implementation was applied to the permanent magnet type dynamo-electric machine of a shaft-orientations gap, it cannot be overemphasized that it is applicable also like the permanent magnet type dynamo-electric machine and permanent magnet type linear motor of a radial gap.

[0033]

[Effect of the Invention] Since the amount of flux linkages of the armature coil by the permanent magnet can be adjusted by sticking the movable magnetic substance to a permanent magnet under the certain conditions at the time of high-speed rotation etc. according to this invention as explained above, an electrical potential difference can be adjusted and controlled and wide range operation from low-speed rotation to high-speed rotation can be realized.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The direction sectional view of a revolving shaft showing the gestalt of 1 operation of the permanent magnet type dynamo-electric machine concerning this invention.
[Drawing 2] The sectional view of the field weak device shown in drawing 1 .
[Drawing 3] The direction sectional view of a path and axial sectional view showing the gestalt of 1 operation of Rota which constitutes the permanent magnet type dynamo-electric machine concerning this invention.
[Drawing 4] The direction sectional view of a revolving shaft showing the gestalt of other operations of the permanent magnet type dynamo-electric machine concerning this invention.
[Drawing 5] The direction sectional view of a revolving shaft of the permanent magnet type dynamo-electric machine concerning this invention showing the gestalt of other operations further.
[Drawing 6] The sectional view of the field weak device shown in drawing 5 .
[Drawing 7] The direction sectional view of a revolving shaft of the permanent magnet type dynamo-electric machine concerning this invention showing the gestalt of other operations further.
[Description of Notations]
1 -- Stator
2 -- Revolving shaft
3 -- Rota
4 -- Field weak device
12 -- Armature coil
14 -- Permanent magnet
21, 32, 42, 52 -- Movable magnetic substance
23 -- Stopper
33 -- Elastic member
43 -- Slip ring
53 -- Electromagnet

[Translation done.]

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審査請求　未請求　請求項の数６　ＯＬ　（全 ６ 頁）

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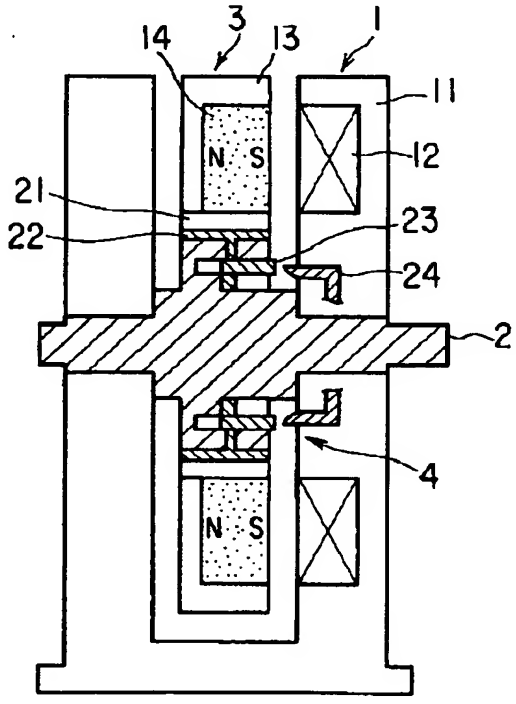
(54)【発明の名称】　永久磁石式回転電機

(57)【要約】

【課題】　高速回転時に電圧を調整・抑制し、低速回転から高速回転までの広範囲の運転を実現することにある。

【解決手段】　電機子コイル１２が装着されているステータ１と、このステータに対して所定の空隙を介して主界磁の永久磁石１４が対向配置されたロータ３と、所定の条件が成立した時、前記永久磁石の磁気回路を短絡する可動磁性体２２を有する界磁弱め機構４とを設けた永久磁石式回転電機である。



【特許請求の範囲】
【請求項１】　電機子コイルが装着されているステータと、
このステータに対して所定の空隙を介して主界磁の永久磁石が対向配置されたロータと、
所定の条件が成立した時、前記永久磁石の磁気回路を短絡する可動磁性体を有する界磁弱め機構と、
を備えたことを特徴とする永久磁石式回転電機。
【請求項２】　所定の条件は、前記ロータの所定値以上の高速回転、前記ロータの前段側回路の異常、所定値以上の負荷状態の何れ１つである請求項１記載の永久磁石式回転電機。
【請求項３】　界磁弱め機構は、Ｔ字形状に形成され、その前端部側が永久磁石に対して所定の空隙をもって可動可能に配置され、後端部の一側部方向に舌片をもつ前記可動磁性体と、この可動磁性体を挿通する長孔が形成され、通常運転時．当該可動磁性体の舌片が係合されるストッパと、前記所定の条件のとき、前記ストッパを移動させて前記長孔から舌片を離脱するストッパ押し部材とを備え、この離脱された可動磁性体がロータ回転の遠心力および永久磁石の磁力を利用して当該永久磁石に密着させることを特徴とする請求項１記載の永久磁石式回転電機。
【請求項４】　界磁弱め機構は、前記永久磁石に対して所定の空隙をもって可動可能に配置された板状の可動磁性体と、この可動磁性体と回転軸とを接続し、弾性力とロータ回転の遠心力と永久磁石の磁力とに抗して可動磁性体を前記永久磁石に密着させる弾性体とを備えたことを特徴とする請求項１記載の永久磁石式回転電機。
【請求項５】　界磁弱め機構は、Ｔ字形状に形成され、その前端部側が永久磁石に対して所定の空隙をもって可動可能に配置され、後端部の一側部方向にテーパ部付き突片をもつ前記可動磁性体と、この可動磁性体のテーパ部と対向する側にテーパ部をもつスリップリングと、前記所定の条件のとき、前記スリップリングを所定距離後退させ、前記可動磁性体がロータ回転の遠心力および永久磁石の磁力を利用して当該永久磁石に密着させる駆動制御部とを備えたことを特徴とする請求項１記載の永久磁石式回転電機。
【請求項６】　界磁弱め機構は、永久磁石に対して所定の空隙をもって可動可能に配置された可動磁性体と、この可動磁性体の前記永久磁石とは反対側に設置され、前記可動磁性体を吸着・離脱させる電磁石とを備えたことを特徴とする請求項１記載の永久磁石式回転電機。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は永久磁石を用いた永久磁石式回転電機に関する。
【０００２】
【従来の技術】一般に、軸方向永久磁石界磁方式の回転電機は以下のような構成となっている。この回転電機はステータとロータが所定の空隙をもって対向配置され、そのうちステータ側は、電機子鉄心を有し、この電機子鉄心にはコイルが巻装されている。ロータ側は、界磁磁束を発生する永久磁石が固定・配置されている。
【０００３】この永久磁石式回転電機は、小型・高出力でメンテナンス性に優れ、かつ、誘導機に比べて励磁電流の可変が可能であるために制御性に優れており、最近では、電気推進システム等を含む多くの技術分野で広く利用されている。
【０００４】本来、電気自動車等の電気推進システムやコンプレッサ等に使用するモータは、低速領域では定トルク運転であるが、高速領域では定出力運転となる。従って、定トルク領域では端子電圧が回転数にほぼ比例して大きくなるが、定出力領域ではトルクが小さく、電流も少なくてよいことから、電圧が一定の値となることが望ましい。
【０００５】しかし、永久磁石式回転電機は、界磁に永久磁石を用いているので、界磁磁束は一定となる。その結果、電機子コイルと鎖交する磁束量は一定であるが、ロータの回転数を上げると、この回転数に比例して誘起電圧が高くなるので、回転電機前段側のインバータの電圧よりも高くなると、インバータ側から回転電機に電流が流れ込まなくなり、回転電機の回転が不能となる。この回転電機の高速回転を可能とする場合には、単純にインバータの電圧を大きくすればよいが、インバータの皮相電力が大きくなり、インバータは大型化し、また変換効率も悪くなる。
【０００６】そこで、従来、界磁磁束と逆方向に作用する電機子反作用のｄ軸成分（ベクトル成分）の電機子電流を流すことにより、電機子コイルと鎖交する界磁磁束を低下させるようにした等価的な弱め界磁制御の技術が用いられている。
【０００７】
【発明が解決しようとする課題】しかしながら、以上のような弱め界磁制御技術は、永久磁石の比透磁率が真空の比透磁率（１．０）に近い値（１．１）となるので、電機子側からロータ側の界磁をみたとき、磁気的空隙長が永久磁石厚みと機械的空隙長との和となり、非常に大きくなる。その結果、弱め界磁の効果を適切に得るためには、ｄ軸の電機子電流がかなり大きくしなければならず、効率的．温度的に問題となり、実用上の面からも問題がある。
【０００８】また、永久磁石自身にも電機子反作用によって反磁界が直接加わるといった問題があり、さらに特性が劣化（減磁）するおそれがある上、磁束弱め中のインバータの故障も問題となる。これは、磁束弱めを行っている最中に、何らかの理由によってインバータが動作しなくなった時、慣性で回り続けるロータによって発生する逆起電力による高い電圧がそのままインバータ或い

は直流側に流れ込んで種々の回路に悪影響を与える可能性がある。

【０００９】そこで、従来の弱め界磁制御技術では、インバータ等の異常の問題が考えられるので、高速回転域の幅を狭めた状態で使用しており、より広い回転速度範囲の運転が難しい。

【００１０】本発明は、上記実情に鑑みてなされたもので、低速回転から高速回転まで広範囲の運転を可能とし、特に高速回転時や前段回路の異常時等に確実に誘起電圧を抑制し、前段回路に何ら悪影響を及ぼさない安全性の高い永久磁石式回転電機を提供することにある。

【００１１】

【課題を解決するための手段】本発明は、上記課題を解決するために、電機子コイルが装着されているステータと、このステータに対して所定の空隙を介して主界磁の永久磁石が対向配置されたロータと、ロータが所定値以上の高速回転となったとき、前記ロータの前段側回路が異常となったとき、所定値以上の負荷状態となったとき、永久磁石の磁気回路を短絡する可動磁性体を有する界磁弱め機構とを設けた永久磁石式回転電機である。

【００１２】なお、界磁弱め機構としては、下記する複数の構成のものが考えられる。

（１）　その１つは、Ｔ字形状に形成され、その前端部側が永久磁石に対して所定の空隙をもって可動可能に配置され、後端部の一側部方向に舌片をもつ前記可動磁性体と、この可動磁性体を挿通する長孔が形成され、通常運転時，当該可動磁性体の舌片が係合されるストッパと、前記所定の条件のとき、前記ストッパを移動させて前記長孔から舌片を離脱するストッパ押し部材とを有し、この離脱された可動磁性体がロータ回転の遠心力および永久磁石の磁力を利用して当該永久磁石に密着させる構成である。

（２）　他の１つは、永久磁石に対して所定の空隙をもって可動可能に配置された板状の可動磁性体と、この可動磁性体と回転軸とを接続し、弾性力とロータ回転の遠心力と永久磁石の磁力とに抗して可動磁性体を前記永久磁石に密着させる弾性体とを設けた構成である。

（３）　さらに、他の１つは、Ｔ字形状に形成され、その前端部側が永久磁石に対して所定の空隙をもって可動可能に配置され、後端部の一側部方向にテーパ部付き突片をもつ前記可動磁性体と、この可動磁性体のテーパ部と対向する側にテーパ部をもつスリップリングと、前記所定の条件のとき、前記スリップリングを所定距離後退させ、前記可動磁性体がロータ回転の遠心力および永久磁石の磁力を利用して当該永久磁石に密着させる駆動制御部とを設けた構成である。

（４）　さらに、他の１つは、永久磁石に対して所定の空隙をもって可動可能に配置された可動磁性体と、この可動磁性体の前記永久磁石とは反対側に設置され、前記可動磁性体を吸着・離脱させる電磁石とを設けた構成である。

【００１３】本発明は、以上のような手段を講じたことにより、界磁弱め機構は、ロータの所定値以上の高速回転、ロータ前段側回路の異常、所定値以上の負荷状態となったとき、ロータ回転の遠心力および永久磁石の磁力等を利用して可動磁性体を移動させて永久磁石に密着させるので、永久磁石の磁気回路が短絡され、この永久磁石の磁束の一部が可動磁性体を通って漏れ磁束となるので、電機子コイルとの鎖交磁束量が減少し、回転電機から発生する電圧を抑えることができる。

【００１４】

【発明の実施の形態】

（第１の実施の形態）図１および図２は本発明に係わる永久磁石式回転電機の一実施形態を示す回転軸方向断面図および界磁弱め機構図である。なお、この実施の形態は、軸方向ギャップであり、かつ、４極構造の回転電機の適用例である。

【００１５】先ず、本発明に係わる永久磁石式回転電機を説明するに先立ち、従来の回転電機との関係を説明する。従来、永久磁石式回転電機に対し、負のｄ軸電流の電機子反作用による永久磁石の磁束を低減させて端子電圧を調整する等価弱め界磁制御法があるが、永久磁石の磁束量を低減させるにはかなりの電機子電流を必要とする。このため、電機子反作用による弱め界磁の効果は小さく、高速回転領域を拡大することは難しい。また、永久磁石に電機子反作用により反磁界が直接加わり、減磁するおそれがある。

【００１６】そこで、本発明に係わる永久磁石式回転電機は、以上の観点を踏まえつつ、実現したものであり、以下、具体的に説明する。すなわち、この回転電機は、断面凹形状に形成されたステータ１と、このステータ１の凹形状をなす空隙部分に回転軸２を介して回転可能に軸支されたロータ３と、界磁弱め機構４とによって構成されている。

【００１７】前記ステータ１は、ケイ素鋼板を積層してなる電機子鉄心１１によって構成され、この電機子鉄心１１には電機子コイル１２が巻装されている。一方、ロータ３は、ロータ鉄心１３で構成され、このロータ鉄心１３の表面に異極の関係にある４個の永久磁石１４が固定・配置されている。この永久磁石１４は、ステータ１側と対峙する側に例えばＳ極、その反対側にＮ極が位置するように配置され、永久磁石１４から発生する界磁磁束がステータ１の電機子鉄心１１および回転軸２を通って一巡するようになっている。

【００１８】前記界磁弱め機構４は、回転軸２のロータ固定ベースと永久磁石１４との間に所定の隙間２１を形成するとともに、この隙間２３１から回転軸心方向にＴ字形状の可動磁性体２２が進退可能にストッパ２３に挿入されている。

【００１９】この可動磁性体２２は、その前端部が隙間

２１部分に位置し、後端部の一側部方向に舌片２２ａが形成されている。ストッパ２３は、ロータ固定ベースの回転軸方向となる一側面から可動磁性体２２の挿入方向と直交する方向に進退自在に挿入され、図２に示すように例えば楕円形状の長孔２３ａが形成されている。そして、常時は、可動磁性体２２の舌片２２ａがストッパ２３の長孔２３ａに係合されており、ストッパ押し部材２４により押されてストッパ２３が所定距離だけ移動したとき、長孔２３ａから外れるような構成となっている。

【００２０】従って、以上のような構成の実施の形態によれば、低速回転および所定値以下の高速回転を含む通常回転時、ストッパ押し部材２４はストッパ２３から所定の間隔だけ離れた位置に設定されている。さらに、可動磁性体２２は、ストッパ２３の長孔２３ａに挿入され、当該可動磁性体２２の舌片２２ａが長孔２３ａの一端側に係合され、永久磁石１４と所定の空隙をもって配置されている。

【００２１】この状態においてロータ３が回転すると、その回転数に比例して誘起電圧が大きくなっていく。そして、ロータ３の回転数が高くなり、所定の回転数以上の高速回転となったとき、ストッパ押し部材２４がストッパ２３を所定距離だけ押し込むように前進する。ここで、ストッパ２３の移動に伴なって長孔２３ａの位置も移動するので、動磁性体２２の舌片２２ａがストッパ２３の長孔２３ａから外れる。

【００２２】その結果、可動磁性体２２が可動状態になるので、ロータ回転の遠心力と永久磁石１４の磁力とにより永久磁石１４に密着する。つまり、可動磁性体２２は永久磁石１４の両極に短絡し漏れ磁気回路となる。これにより、永久磁石１４の磁束の一部が可動磁性体２２を通って漏れ磁束となり、電機子コイル１２との鎖交磁束量が減少し、回転速度が抑制されるので、誘起電圧が抑制される。

【００２３】なお、上記実施の形態は、ロータ３の回転数が所定の回転数以上になったとき、ストッパ押し部材２４を駆動する構成としたが、例えば所定の回転数以上の高速回転を検出せず、何らかの原因でインバータ等が動作しなくなる等の非常時にストッパ押し部材２４を駆動させる構成でもよい。この場合にも可動磁性体２２が永久磁石１４の両極を短絡することにより、永久磁石１４の磁束の一部が漏れ磁束となり、電機子コイル１２との鎖交磁束量が減少する。その結果、ロータ３は慣性で回り続けても、逆起電力による高い電圧を抑えることができ、インバータ或いは直流側に悪影響を及ぼすようなことがない。

（第２の実施の形態）図３および図４は本発明に係わる永久磁石式回転電機の他の実施形態を示すロータ構成図および回転軸方向断面図である。

【００２４】この実施の形態は、界磁弱め機構４として、回転軸２のロータ固定ベースと永久磁石１４との間に所定の隙間３１が形成され、この隙間３１部分に板状の可動磁性体３２を配置されている。さらに、可動磁性体３２と回転軸２がスプリング等の弾性部材３３を接続されている。

【００２５】このような構成の実施の形態によれば、低速回転から所定の高速回転までは、弾性部材３３の弾性力が遠心力＋磁力よりも勝るように設定されている。そのため、ある負荷状態または定トルク領域では、可動磁性体３２が永久磁石１４から離れているので、永久磁石１４は本来の性能を発揮し、電機子コイル１２との鎖交磁束量が大きくなる。

【００２６】一方、高速回転時には、ロータ回転の遠心力＋磁力がバネ弾性力より大きくなるように設定する。その結果、高速回転領域では、バネ弾性力に抗して永久磁石１４が可動磁性体３２を密着することにより、永久磁石１４の磁気回路を短絡する磁路が形成され、界磁磁束の一部がバイパスされるので、永久磁石１４の磁束の一部が漏れ磁束となり、電機子コイル１２との鎖交磁束量が減少する。これにより、回転電機の端子電圧を低下させることができ、インバータから回転電機に電流が流れ込まないといった不都合な問題がなくなり、広範囲の回転領域にわたって運転が可能となる。

（第３の実施の形態）図５および図６は本発明に係わる永久磁石式回転電機の一実施形態を示す回転軸方向断面図および界磁弱め機構図である。

【００２７】この回転電機における界磁弱め機構４は、回転軸２のロータ固定ベースと永久磁石１４との間に所定の隙間４１が形成され、この隙間４１から回転軸心方向にＴ字形状の可動磁性体４２が進退可能に挿入されている。

【００２８】この可動磁性体４２は、その前端部が隙間４１部分に配置され、後端部の一側部方向に折曲して内側部分をテーパ状とした突片４２ａが形成されている。そして、可動磁性体４２の進退方向と直交する方向にテーパ部をもつスリップリング４３が進退可能に設けられている。そして、このスリップリング４３のテーパ部と突片４２ａのテーパ部とが互いに係合し合う状態に設定されている。

【００２９】このような構成の実施の形態によれば、回転数，負荷，温度，インバータ等野異常に伴なって、スリップリング４３が後退するように移動すると、突片４２ａのテーパ部が遠心力＋磁力のバランスの下にスリップリング４３のテーパ部に係合しつつ永久磁石１４に近づくように可動し、永久磁石１４に密着させることができる。これによって第１，第２の実施の形態と同様に可動磁性体４２が永久磁石１４の両極を短絡し、永久磁石１４の磁束の一部が漏れ磁束となり、電機子コイル１２との鎖交磁束量を減少させることができる。

【００３０】この実施の形態の場合には、自由な条件設定の下にスリップリング４３を駆動すれば、回転電機の

最適な運転を確保できる。

（第４の実施の形態）図７は本発明に係わる永久磁石式回転電機の一実施形態を示す回転軸方向断面図である。

【００３１】この回転電機における界磁弱め機構４は、回転軸２のロータ固定ベースと永久磁石１４との間に所定の隙間５１が形成され、この隙間５１部分に板状の可動磁性体５２が配置されている。さらに、板状の可動磁性体５２の永久磁石１４とは反対側に電磁石５３を配置し、この電磁石５３の励磁および非励磁制御により、可動磁性体５２を永久磁石１４に密着させたり、離反させたりする構成である。

【００３２】このような構成の実施形態によれば、第３の実施の形態と同様に回転数，負荷，温度，インバータの異常等の条件の下に、電磁石５３を非励磁または励磁制御することにより、電磁石５３から可動磁性体５２から離反するようにすれば、遠心力＋磁力により、可動磁性体５２を永久磁石１４に密着させることができ、第１ないし第３の実施の形態と同様な動作ないし機能を発揮させることが可能である。　なお、上記各実施の形態は、軸方向ギャップの永久磁石式回転電機に適用したが、ラジアルギャップの永久磁石式回転電機や永久磁石式リニアモータにも同様に適用できることは言うまでもない。

【００３３】

【発明の効果】以上説明したように本発明によれば、高速回転時等の一定の条件下で永久磁石に可動磁性体を密着させることにより、永久磁石による電機子コイルの鎖交磁束量を調整できるので、電圧を調整・抑制でき、低速回転から高速回転までの広範囲の運転を実現できる。

【図面の簡単な説明】

【図１】　本発明に係わる永久磁石式回転電機の一実施の形態を示す回転軸方向断面図。

【図２】　図１に示す界磁弱め機構の断面図。

【図３】　本発明に係わる永久磁石式回転電機を構成するロータ側の一実施の形態を示す径方向断面図および軸方向断面図。

【図４】　本発明に係わる永久磁石式回転電機の他の実施の形態を示す回転軸方向断面図。

【図５】　本発明に係わる永久磁石式回転電機の更に他の実施の形態を示す回転軸方向断面図。

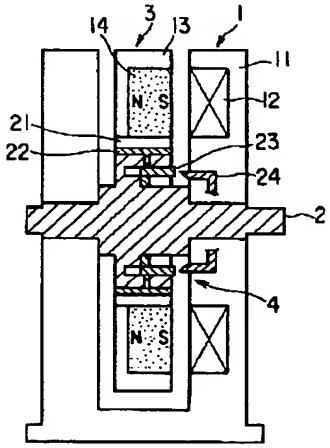
【図６】　図５に示す界磁弱め機構の断面図。

【図７】　本発明に係わる永久磁石式回転電機の更に他の実施の形態を示す回転軸方向断面図。

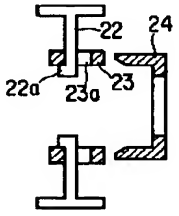
【符号の説明】

１…ステータ
２…回転軸
３…ロータ
４…界磁弱め機構
１２…電機子コイル
１４…永久磁石
２１、３２、４２、５２…可動磁性体
２３…ストッパ
３３…弾性部材
４３…スリップリング
５３…電磁石

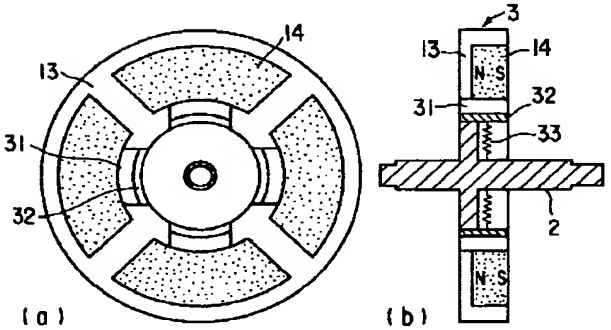
【図１】



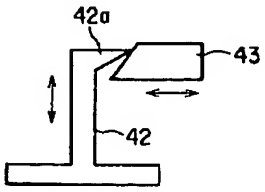
【図２】



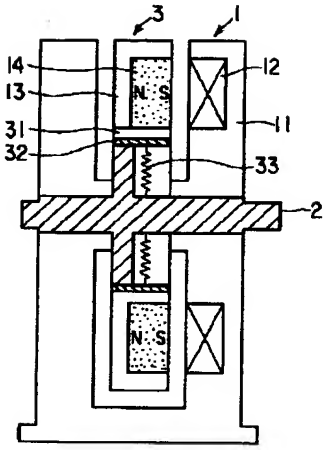
【図３】



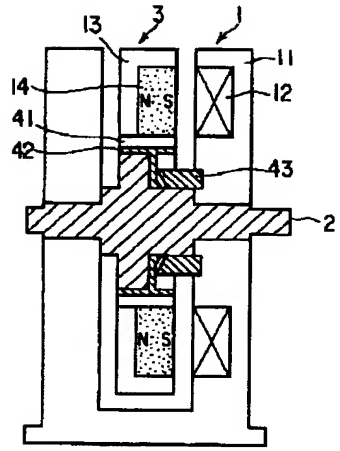
【図６】



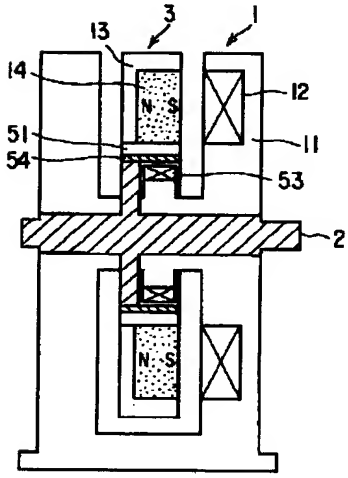
【図４】


3
1
14
13
12
N S
31
11
32
33
2
N S

【図５】


13
3
1
11
14
N S
12
41
42
43
2
N S

【図７】


13
3
1
14
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12
51
11
54
53
2
N S